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NASA CASE NO. LAR-13,564-1
PRINT FIG. 3

13P

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LaRC

(NASA-Case-LAR-13564-1) MINIATURE REMOTE
DEAD WEIGHT CALIBRATOR Patent Application
(NASA) 13 p Avail: NTIS HC A02/MF A01
CSCL 14B

N87-25558

Unclas

G3/35 0083869

MINIATURE REMOTE DEAD WEIGHT CALIBRATOR

AWARDS ABSTRACT

NASA Case No. LAR 13564-1

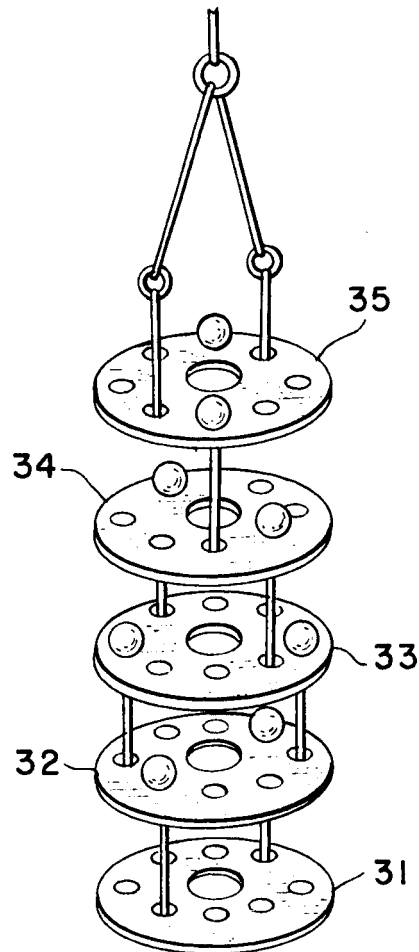
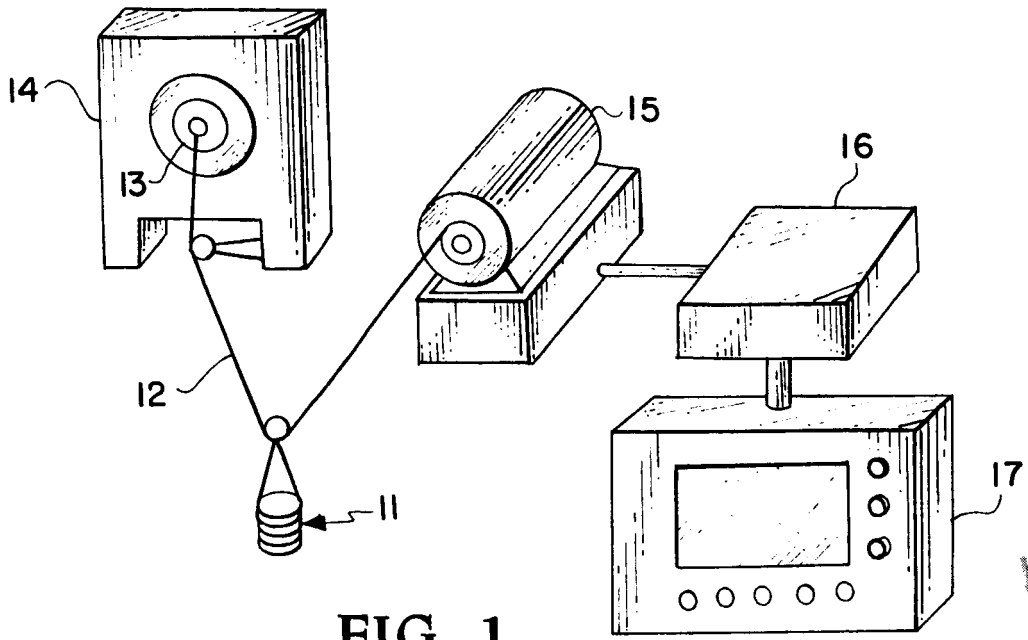
The invention is a miniature dead weight calibrator 10 which can be used for the calibration of miniature force transducers such as those associated with the cryogenic wind tunnel of the National Transonic Facility. The invention comprises a specially-designed set of five interlocking 200 milligram weights 11, a motorized lifting mechanism 15, a controller 16, and a microcomputer 17. Operation of the invention allows the automatic sequential loading and unloading of each of the five dead weights while the transducer is located within a cryogenic chamber 22.

The novelty of the invention is the interlocking mechanism which provides for the automatic sequential operations and which also minimizes support structure weight and reduces the size of the conduction path entering the cryogenic chamber.

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SECRET 1 OF 3
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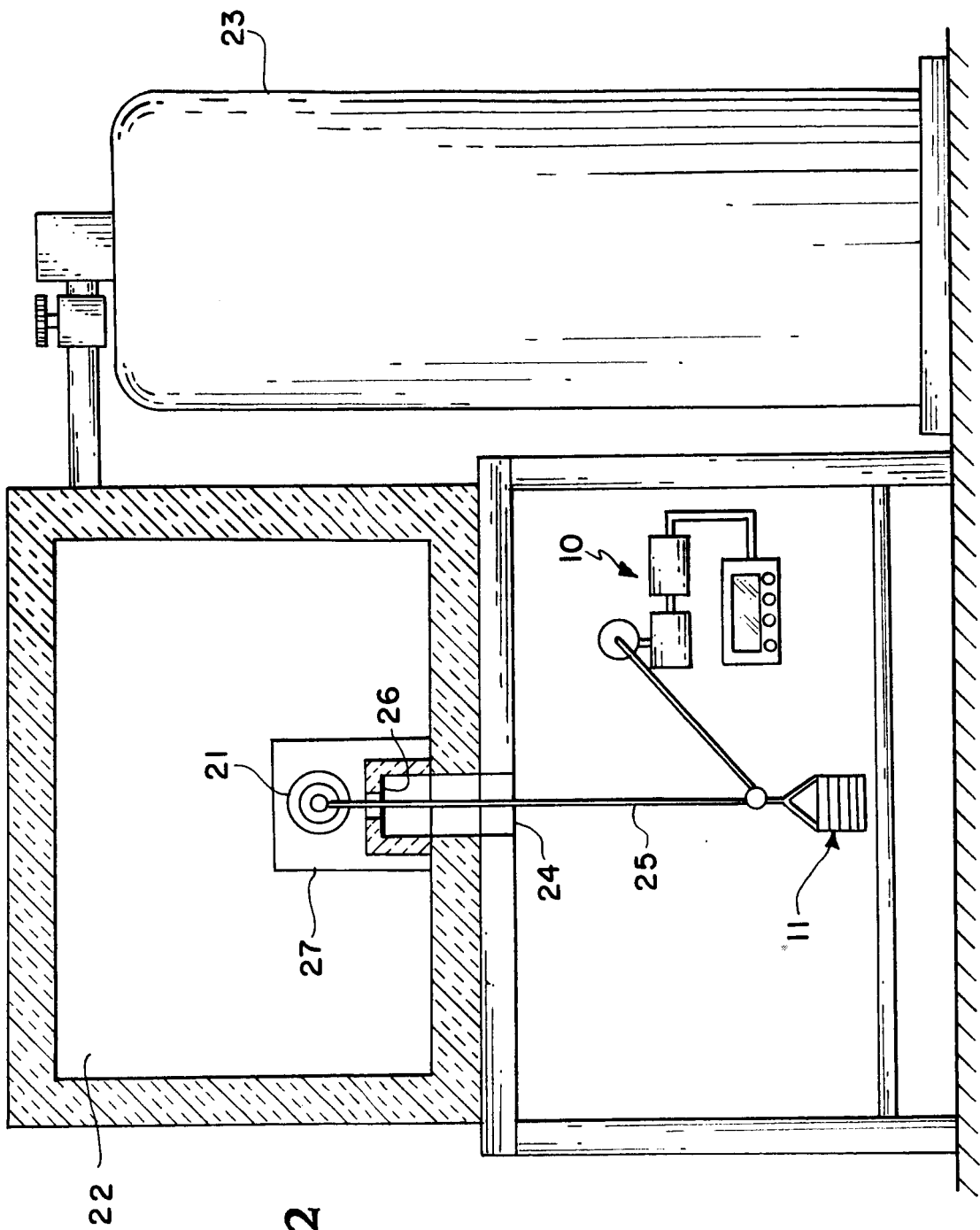


FIG. 2

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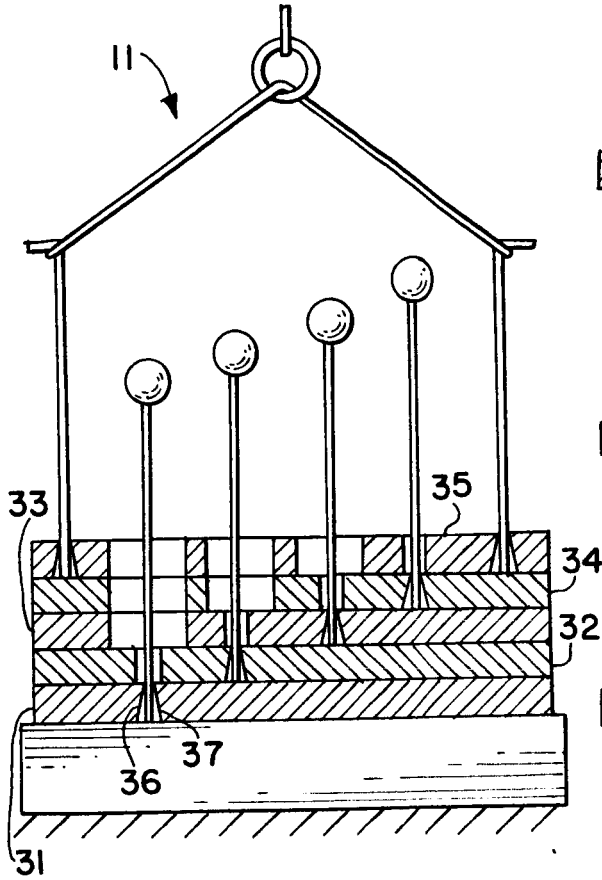


FIG. 3

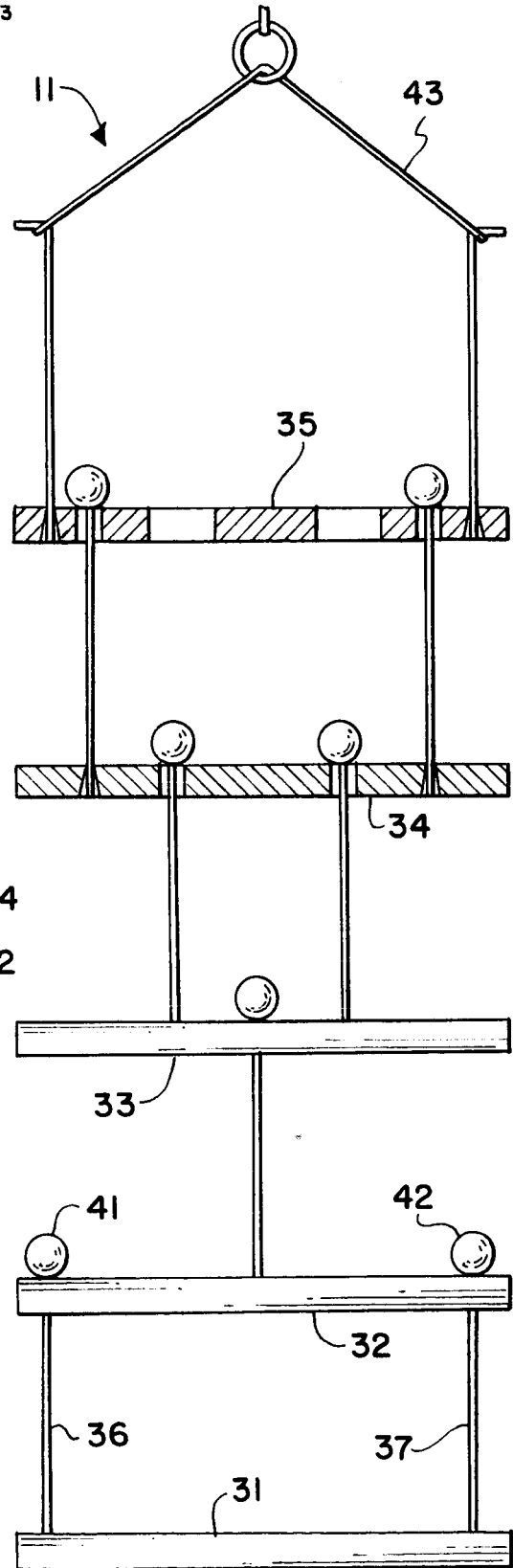


FIG. 4

NASA CASE NO. LAR-13564-1
SHEET 3 OF 3
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MINIATURE REMOTE DEAD WEIGHT CALIBRATOR

Origin of the Invention

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The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

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Technical Field of the Invention

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The invention is related to calibration of wind tunnel force transducers and more particularly to calibration of wind tunnel devices using dead weights.

Background of the Invention

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The recent development of the National Transonic Facility (NTF), a cryogenic transonic wind tunnel located at the National Aeronautics and Space Administration, Langley Research Center, has created a need for wind tunnel instruments capable of operating at cryogenic temperatures. A particular instrument is a miniature skin friction balance comprising a sensitive force transducer. This transducer is a servoed instrument that makes direct measurement of aerodynamic drag produced by an airflow along the surface of the test model or along the wind tunnel wall.

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Calibration of this transducer requires that the device be mounted so that the sensitive axis is aligned vertically and that a series of pre-calibrated weights be sequentially loaded to determine the transducer response. Because the wind tunnel operates at cryogenic temperatures, the mounted balance must be placed in a cryogenic chamber for proper calibration. Prior to the development of the present invention, it was necessary to calibrate the transducer manually. A port through the floor of the chamber allowed a weight basket to be suspended from the sensing element of the transducer to the outside of the chamber. The calibration procedure required a sequential loading of 200

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milligram weights up to 1000 milligrams, followed by a sequential unloading back to no-load. Handling of delicate weights required in this calibration was difficult due to the awkward location under the cryogenic chamber. Further, repetitive calibrations for a variety of temperatures were required. As none of the prior art devices for automated calibration were suitable for the needs of the cryogenic wind tunnel, a device was needed to allow rapid, automatic sequential loading to the transducer while it was located within the cryogenic chamber. Further, the movement of the suspension line coming from the chamber was very small requiring that the loading of weights not depend on movement of the transducer balance or of the suspension line from the balance.

A variety of prior art devices exist which provide sequential loading by a large movement of a suspension arm, such arm picking up dead weights during movement.

Other prior art devices provide static load changes using screws for load control or using force transducers as references. These devices are not sufficiently accurate for the calibration of the miniature device of the cryogenic wind tunnel.

Other devices required intrusion into the cryogenic chamber because of the necessity to apply forces to the balance directly.

Accordingly, the present invention is developed to meet the following objectives.

An object of the present invention is to provide a remote, automatic calibration device suitable for calibrating small-load devices for cryogenic wind tunnels.

A further object of the present invention is to provide for successive sequential loading and unloading of calibration weights.

Another object of the present invention is to provide a device capable of calibrating wind tunnel devices while those devices are located in cryogenic chambers.

Yet another object of the present invention is to provide for calibration of a wind tunnel device by loading

and unloading reference weights while the transducer load point remains relatively stationary.

5 Statement of the Invention

According to the present invention, the foregoing and other objects are attained by providing a miniature, computer-controlled, dead weight calibrator which unloads and loads preselected weights through commands of a microcomputer.

10 In the preferred embodiment of the present invention, the calibrator comprises a specially-designed set of five interlocking 200 milligram weights, a motorized lifting mechanism, a controller module and a microcomputer. The interlocking weights are arranged so that as the assembly is lifted, first one weight and then the next is supported. In this manner, a sequential loading of each weight is accomplished when the associated interconnecting rod height has been reached. The linking assembly allows the automatic sequential loading and unloading

20 Brief Description of the Drawings

25 For a more complete understanding of the present invention and the many advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic of the general arrangement of the present invention and the calibration fixture arrangement;

30 FIG. 2 is a view of the present invention as installed with the cryogenic chamber and calibration fixture;

FIG. 3 is a conceptual side view of the interlocking mechanism and dead weights of the present invention in the unloaded position;

35 FIG. 4 is a conceptual side view of the interlocking mechanism and dead weights in the loaded position; and

FIG. 5 is a perspective view of the interlocking mechanism and weight in an unloaded position.

Detailed Description of the Invention

Referring now to FIG. 1, a perspective view of the combination of the present invention is designated generally by the numeral 10. The interlocking mechanism and dead weight assembly 11 is depicted in the unloaded position with load wire 12 running from the force transducer 13 mounted in calibration fixture 14. The calibration fixture is to be mounted inside a cryogenic chamber, not shown in this view, for actual calibration. Load wire 12 is also attached to electric winch 15 which lifts the interlocking mechanism and dead weight assembly 11 during calibration. Electric winch 15 is attached to control module 16 which is in turn controlled by microcomputer 17. The specific equipment used in the present invention included a digital linear actuator, commercially available as AIRPAX Model L92421-P2 to provide lifting in steps, a linear actuator driver as a controller, commercially available as AIRPAX Model K33505, and a computer brand Apple IIe. Any similar substitutes will be equally suitable, however.

FIG. 2 is a schematic of the overall configuration of the present invention 10 installed for calibration of a force transducer 21 in a cryogenic chamber 22. The cryogenic chamber 22 is supplied with liquid nitrogen from tank 23 to maintain cryogenic condition. Access port 24 permits load wire 25 to exit the floor of the cryogenic chamber to provide for suspension of the dead weight assembly 11. A seal 26 is provided on the underside of mounting fixture 27.

FIG. 3 shows a notional side view of the interlocking mechanism and dead weight assembly 11 in the unloaded position. The assembly comprises pairs of rods bonded to each individual dead weight washer and slideably attached to the adjacent dead weight washer. Specifically dead weight 31, the lower-most dead weight, has rod-pair 36 and 37 bonded to the weight and slideably interconnected to the next adjacent dead weight washer 32. Dead weight washers 33, 34 and 35 are then over-bored so that rod-pair 36 and 37 can freely pass through without interference. This

arrangement causes each dead weight to be lifted when the lifting force is applied to the bonded rod-pair. The total weight of each dead weight-rod combination in this invention is only 0.2 grams. This miniature weight requirement dictates a novel linking of the weights to prevent overloading the balance. A heavier, single support attached to all weights is unsuitable. Further, such a heavier, single support would provide additional problems of sealing and conduction from the cryogenic chamber.

FIG. 4 depicts the interconnecting mechanism and dead weight assembly 11 in the fully loaded position. Dead weight washer 31 is supported by rod-pair 36,37 which have been slideably positioned against the rod stops 41 and 42. In a similar manner, each of the other dead weight washers are supported through the interlocking rods slideably connected to the next adjacent dead weight. Lifting the assembly from the top by support wire 43 causes washer 35 to be lifted, followed by washer 34, and so on until the entire assembly is lifted. Likewise, as the assembly is set down, washer 31 is first unloaded, when washer 32, and so on in sequence. This automatic function allows the calibration reading to be obtained at five data points during both loading and unloading of the force transducer. Other methods of loading the assembly may be accomplished without departing from the spirit of the invention. Loading could be accomplished by lowering the dead weight support platform, for example.

FIG. 5 shows the preferred embodiment of the present invention in the unloaded position with the dead weights forming washers having bore holes to permit either the passage of the interconnecting rod only, or the passage of both rod and rod stop as required to establish the interlocking links.

Operation of the Invention

For manual calibration, the controller is used to position the lift so as to unload the last (bottom) weight from the weight system. This is determined by sighting, and

centers the platform between the position of it first touching the weight and raising it to touch the next weight. The number of steps displayed by the LEDs to drive the actuator to this position is noted. The unloading procedure is repeated for the individual weights until the entire weight system is unloaded from the balance, resulting in the lift position required for each weight increment of the interlocking weights.

For automatic calibration, the initial setup determines the number of actuator steps required to position the lift for each load increment of the interlocking weight system. This set of data and the values determined for the individual weights are entered into the software program of the micro-computer. Other information entered at the start of the computer program includes the balance identification, the current calibration temperature, the number of readings to be taken at each point to be averaged, and the number of times the calibration is to be repeated, if any.

A computer program is now run and the calibration is executed. The lift first lowers the interlocking weights to unload the balance and set an initial zero signal. The lift then operates to apply the incremental loads and the average balance output signal level is recorded by the computer in the order of: zero, 200 mg, 400 mg, 600 mg, 800 mg, 1000 mg, 800 mg, 600 mg, 400 mg, 200 mg, zero. The temperature can then be changed, allowing the time required for stabilization, and the program is then run to do the next calibration.

Although the invention has been described relative to a specific embodiment thereof, it is not so limited and numerous variations and modifications thereof will be readily apparent to those skilled in the art in light of the above teachings. For example, as noted in the specification, various components may be used for the control and operation of the invention. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by
Letters Patent of the United States is:

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MINIATURE REMOTE DEAD WEIGHT CALIBRATOR

Abstract of the Invention

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The invention is a miniature, remote, computer-controlled dead weight calibrator 10. This device comprises an interlocking rod and dead weight assembly 11, a motorized lifting mechanism 15, a controller 16 and a microcomputer 17. The device allows automatic calibration of force transducers needed for wind tunnel operations while the transducers are located within a cryogenic chamber 22. The operation of a cryogenic transonic wind tunnel requires calibration of force transducers at cryogenic operating temperatures. The present invention allows remote, automatic, and sequential loading and unloading of pre-selected weights.